AMRAD NEWSLETTER

Amateur Radio Research and Development Corporation May June 84

The following is the list of monthly AMRAD meetings (Note that September is not the first Monday, as that is a holiday):

February 6	Hal Feinstein on Spread Spectrum
March 5	
April 2	
May 7	Update on Trenton and Dayton
June 4	Horse Race Preparations
July 2	Heath/Zenith Computer Systems
August 6	
September 10	
October 1	Digital Data Systems
Nov 5	
December 3	Annual Business Meeting

Upcoming Events

Gaithersburg Hamfest

The hamfest will be held Sunday, September 9, 1984 at the Montgomery County Fairgrounds, Gaithersburg, MD. Talk-in will begin at 6:00 AM for directions and information. W3PRL will be on the air at 146.52. Repeater 146.04/64 will also be used.

October 1--Digital Data Systems

The October 1st AMRAD meeting promises to be quite interesting and informative. Berhnard E. Keiser, D.Sc. in electrical engineering from Washington University and a registered Professional Engineer in Virginia, Maryland and D.C., will be our guest speaker. Dr. Keiser has designed microwave communications systems for the military, conducted technical feasibility studies in satellite communications, and has been a consulting engineer in the field of cable television systems technology. He holds two U.S. patents for voice-signal bandwidth compression and expansion using time domain principles. He has 26 published papers. All in all, it promises to be an enlightening evening--Bring a friend!

Job Hunting?

Federal Express Telecommunications Division is looking for people with associate degrees in electrical engineering or equivalent to install and maintain computer systems. System involves PDP 11/23s at dispatch centers and packet radio in over 7000 vehicles. Positions are open at Los Angeles, San Francisco, Detroit, Denver, Dallas, Albany, Miami, District of Columbia, Chicago and New York City. Salary 25 to 30 k, depending on experience. Contact Doug Baker, K4CLE, Senior Engineer, 2955 Republican, Memphis, TN 38194, 901-797-5767.

New Packet People

A packet-radio club is being formed at Federal Express in Memphis TN. Those interested should contact Doug Baker, K4CLE, 8724 Cumbernauld Circle, Germantown, TO 38138.

Daughter Boards Available

To get your your VDS-1 board (bare) and its documentation, send $25.00 plus $2.25 for shipping (US funds) to:

Technetronics Systems Inc.
ATTN: Charles D. Phillips
6134 Columbia Pike
Falls Church, VA 22041

A LETTER TO AMRAD FROM TERRY FOX, WB4JFI

I have learned a valuable lesson over the last year, unfortunately at AMRAD's expense. That lesson is not to take on too much, or nothing will get accomplished. I am writing this to apologize to AMRAD, and offer some reasons as to how this came about.

As most of you are aware, Paul Rinaldo left AMRAD to become the manager of the Technical Department of the ARRL about a year ago. Paul was the founding President of AMRAD, and devoted most of his time running AMRAD. Some of the things he did were: setting up the monthly meetings; lining up speakers for the meetings; coordinating the many symposiums AMRAD has held; running the deaf grant projects; editing the monthly newsletter; doing the club correspondance; keeping us technical types in line; and the other things normally associated with running a club. Fortunately, since Paul had retired from his other (read paying) full-time job, and he had the expertise, he accomplished all of the above wonderfully.

When Paul announced he was leaving, the rest of us knew that it would take some time and a lot of effort before AMRAD would recover. When Paul left, I became President of AMRAD. Since there were no immediate volunteers, I also became the newsletter editor, and meeting coordinator (Howard Cunningham became the correspondance secretary). This in addition to the technical work I was doing for the club, all in my spare time (I still have to work at a regular job to support my hobby). I slowly realized that all this was becoming too much for me to handle, and I became so bogged down that nothing was being accomplished. That is one reason why the newsletter was not being put out on a regular basis. The other reason is that for a while after Paul left, we weren't getting many articles to put in the newsletter. It became doubly hard when I had to do the technical work and then create the material for, and then edit the newsletter too. This in addition to working a lot of overtime and some personal problems took its toll.

Since then, Deborah Borden (wife of K8MMO) has taken over the newsletter, and is in the process of getting it caught up. She is doing a good job on it, even getting columns from Dave on a regular basis!

I felt it is important to inform the club membership as to why we seemed to be off track over the last year. The above is not presented as an excuse, but rather a portion of the reasons why we have had problems. I truly feel we are on the up-side of recovering from Pauls move, although I think it will still take a while to fully recover (if ever).

I am sorry that I had to learn this lesson at AMRAD's expense. I hope that this has not caused too much of an inconvience to the members.

My last comment is to thank the club members who have hung in there. I really appreciate your help and continued support. AMRAD is still on the forefront of Amateur technology, that never changed or slowed. We continue do develop packet radio technology, have a new two-year STA for spread spectrum experimentation, continue to work with and support the hearing-impaired community, and are willing to work in other technical areas.

Thank you once again for your support and understanding.

SPREAD SPECTRUM

Hal Feinstein, WB3KDU
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Arlington, VA 22209
703-524-9116 home

Recently, I was asked by a friendly offical at the FCC about our experiments. He said, "You hams are just interested in making a secure (meaning secret) communications systems, aren't ya?" Well, I told him that of course us hams aren't interested in secret communications but in what new and interesting properties some of these techniques can provide. In particular, spread spectrum has some properties that allow us to shape the spectral profile of a radio signal, so that it can be made to fit any kind of space available on the spectrum. When I told that to the FCC man, he was perfectly satisfied with the answer and allowed us to go ahead with the experiments we are planning.

A few weeks after this conversation, the FCC issued us a special temporary authorization (STA) and a letter from their field engineering bureau (FOB) say that we could experiment with spread spectrum in the amateur bands but, we have to ring up their monitoring station located in Washington, D.C. before we begin.

Other than this desire to coordinate our experiments, no other major restrictions were levied by the Commission. So we are off to the lab to start experiments.

The first experiment being built as I write this is a channel selection logic board called the Fox Randomizing Appliance (FRA) after it's designer. The board consists of a 2732 PROM which holds the channel visitation sequence and a bit of control logic to pull out sequential 8 bit entries from the PROM. The clocking is done with a 1 mhz xtal and a divide down circuit arranged so that we can select clocking speeds by DIP switches on the board. This is version one of the FRA, it will give us a non-repeating sequence of channels (in BCD) 4096 channels long. Programming the 2732 is the heart of the matter and must be done so that each 2732 location contains a randomly selected BCD number in the range of zero to one hundred. The BCD equivalent of the number is programmed into the PROM, otherwise, binary numbers will be supplied to the synthesizer channel lines which expect BCD. This results in invoking the don't care status of the synthesizer which in turn can generate unpredictasble channels, perhaps outside the amateur bands.

The 2732 contains 4096 8-bit storage locations which can have a value between 0 and 255. In BCD, this equals about 10 bits of BCD or two and one fifth digits. The inventor of the FRA, Terry Fox, WB4JFI, suggests programming the binary to BCD converter on the output, giving a "pure" 2.2 digits of BCD to feed to the syntheizer. This seems like a good plan.

The Fox Randomizing Appliance will be used to drive the channels of a TEMPO-1 VHF handheld radio for a power profile test to be conducted at Dave's (K8MMO) house in a week or two. Simply, we are trying to verify the enormous balderdash that spread spectrum is both invisible and an unbearable noise source at the same time. The plan calls for putting the TEMPO-1 and the FRA in a car and driving around the area of Dave's house. Others will be watching on spectrum analysers and listening on scanners and receivers at various locations in the surrounding area to note any interference or noise. We will coordinate this via the AMRAD repeater when it comes off.

Experiment number two is a two meter frequency hopping beacon which we are planning to put up at the Electronic Equipment Bank in Vienna, Va. EEB has donated the TEMPO-1 and some space to this project and Scott, WR4S, who works at EEB selling ham gear is going to be the beacon tender. The equipment for the beacon is currently being assembled but will include one C-64 Commodore computer with disk for control of the beacon, one Fox Randomizing Appliance Version 3 (programmable speed, fixed channel selection), the TEMPO-1 vhf handheld (2 meters) and a twenty five watt amplifier.

And now for the protocol section of this column. Since spread spectrum communications calls for highly coordinated and split second accuracy, some kind of protocol is needed to allow the two or more stations to communicate with each other. For the purposes of the beacon, we have come up with a protocol which we call P1. P1 says the following; transmissions start with a unmodulated carrier, then a CW ID of the beacon for the FCC, followed by a program indicator. The program indicator tells which version of the protocol is running and which subsequence of the protocol is currently active. The program indicator will be four digits sent in morse. Then a timing and synchronization sequence which consists of a train of transistions of an AFSK tone. The timing and synchronization train (TST) has two purposes, first it allows listeners to synchronize their clocks with the one used by the beacon, second, it indicates, by the falling edge of the AFSK tone, the actual moment that the hopping sequence starts. The hopping sequence will be published in future issues of this column for those people wanting to experiment and will be available on the AMRAD bulletin board for down-line loading to your computer.

FROGS
or
A Primer on Hoppers

Chuck Phillips
N4EZV

FREQUENCY HOP SIGNALS

The advantages of using frequency hop signals instead of conventional narrowband signals or other wideband signals include the following:

1. Processing gain.
2. Jamming resistance.
3. Traffic privacy.
4. Low probability of intercept.
5. Multiple access capability.
6. Short synchronization time.
7. Multipath rejection, and
8. Near-far performance.

These features are described in the following paragraphs.

PROCESSING GAIN

Frequency hop systems generally possess a large processing gain which allows the systems to operate with a low signal-to-noise ratio at the input of the receiver. The processing gain for frequency hop signals is

$$\text{Processing Gain} = \frac{\text{RF Bandwidth}}{\text{Information Bandwidth}}$$

For example, a frequency hop signal that has a 10 MHz RF bandwidth and an information bandwidth of 1 Khz has a processing gain of 40 db.

$$\text{Processing Gain} = \frac{10 \text{ MHZ}}{1{,}000} = 10{,}000$$

$$= 10 \text{ LOG } 10{,}000 = 40 \text{ db}$$

Thus, the output signal to noise ratio of the frequency hopping demodulator will be 40 db higher than the receiver input signal to noise ratio. This assumes no loss in the demodulator.

JAMMING RESISTANCE

Since a frequency hop signal generally has numerous frequency slots, the only time a narrow band jammer affects signal reception is when the signal hops to a frequency slot that is occupied by the jammer. If the frequency hopper has 500 frequency slots and a narrow band jammer interferes with the signal reception from one of the 500 slots, then only 1/500th of the signal might be jammed. Therefore, the low average power density combined with the pseudorandom frequency hopping make these signals difficult to intercept.

MULTIPLE ACCESS CAPABILITY

Frequency hop systems can be used for multiple access systems, time division, frequency division and code division multiple access systems can all employ frequency hop signals.

Frequency division multiple access systems assign a frequency band for each user. While most frequency division multiple access systems employ narrowband signals, wideband signals could also be used.

SHORT SYNCHRONIZATION TIME

Frequency hop systems generally require a significantly shorter time to acquire synchronization than other types of systems having the same bandwidth. In frequency hop systems the receiver can usually synchronize with the transmitted signal within a small fraction of a second. Direct sequence systems, for instance, require about a second to achieve synchronization. For some applications like voice communications, the shorter acquisition time is highly desirable. If one or two seconds is required for synchronization, the transmitter has to be keyed at least two seconds before the voice will be received at the receiver. Therefore, a voice reply would be delayed by at least two seconds. By using frequency hop signals, the receiver can synchronize within a fraction of a second and no noticeable delay is encountered for voice

MULTI-PATH REJECTION

When the transmitted signal is propagated towards the receiver, several paths may exist which may cause interference due to phase cancellation at the receiver. This is called multipath propagation. If the signal is propagated via the ionosphere, the path delays can range from tens of microsecands to several milliseconds. Similar multipath delays can exist at VHF and UHF frequencies due to reflections from buildings, towers and other reflective materials.

If the hopping rate is adequately high, then the receiver listens on a new frequency slot before the interfering paths have a chance to interfere with the direct path. For slow frequency hoppers, the path propagation times are too fast to allow the receiver to reject the interference. Thus, to be effective, the hopping rate must be kept higher than the inverse of any interfering path delay time.

FREQUENCY DIVERSITY

Frequency hopping systems provide frequency diversity since many frequencies are used in the system. If proper data coding is used, a severe fade at any one particular frequency will have little effect on the data transmission. At HF frequencies, signals fade independently of one another if the frequency separation is several kilohertz. For frequency hop systems to provide frequency diversity, the minimum separation between frequency slots should be greater than several kilohertz. Typically, the separation used is much larger than a few kilohertz, ranging from 20 KHz minimum separation for voice and data communications. Thus, frequency diversity is easily provided for.

NEAR-FAR PERFORMANCE

Frequency hop systems provide better near-far performance than direct sequence systems. Near-far performance describes the behavior of the spread spectrum system with other users both near and far away from the intended users.

TRAFFIC PRIVACY

Frequency hop systems provide a great degree of traffic privacy. The low probability of intercept combined with pseudorandom frequency hopping make these signals difficult to demodulate for unintended receivers. If additional security is desired the intelligence may be further encrypted using additional techniques.

LOW PROBABILITY OF INTERCEPT

Frequency hop signals have a low average power density which can make these signals difficult to intercept. While the instantaneous power level of the frequency that is transmitted is high, the average power of that frequency is equal to the instantaneous power divided by the number of frequency slots. For example, a frequency hop system with 500 frequency slots transmits a specific frequency only a small fraction of the time (1/500th). If the instantaneous power from the transmitter is 100 watts, the average power in any one frequency slot is:

$$\text{Average power per frequency slot} = \frac{100 \text{ watts}}{500 \text{ slots}} = 0.2 \text{ watts}$$

A frequency hop system jumps to many different carrier frequencies in a time interval and filters the carrier frequency with the intermediate frequency filter. Users outside the filter's bandwidth are rejected and only the proper signal is demodulated. Since the I.F. filter passes only a narrow bandwidth, potential interferers are more easily rejected.

If the other users of the frequency band are near the frequency hop receiver and a frequency hop transmitter is far away, a frequency hop system can more easily reject the near-by interference than the direct sequence system can.

Further Adventures in FEC Land

Jerome T. Dijak
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Dayton, Ohio 45424

RECENT HISTORY

The last piece I prepared for this auspicious journal appeared in the December 19833 issue, discussing my plaans for improvements to my Forward Error Correcting (FEC) communications system. (This system had been described in some detail in a previous series of articles.) A lot has happened since thenm aand it seems like a good time to take time out and document a little about what has been going on.

Immediately after the last article appeared, the heavily modified software and new hardqare entered the preliminary testing phase. This was a very frustrating phase which lasted about 90 days. The buld of the problems centered areound the differences between MY computer configuration (a "known"), an WOPHD's (an "unknown"), especially with regard to which interrupt vectors were alreaady in use by other peripherals in the system. (We have differentperipherals, of course.) After a couple of months, and losts of phone calls, we finally got that figured out, and commenced working the bugs out of the FEC ARQ software.

By April (1983) we had an operational system running, and really spent a lot of time using it. Also in April we ran a few characterization tests to claim some records for error-free data transfers on the HF bands. On April 2, 1983 Wally (WOPHD) and I successfully transferred iwthout errors: 1) a 4-Kbyte file of 8-bit computer machine code in 7 mins 25 seconds; 2) 15 simulated third-party messages (ARRL standard format, with 25 word texts) in 7 minutes and 40 seconds, and 3) an 8-Kbyte compputer machine code file in 21 minutes. All these were done at 300 bps using 425 Hz shift on 14.080 MHz with about 80 watts output power at each end of the link and using the W8JD FEC ARQ System. At the time, we were operating between Ithaca, New York and Warren, Minnesota. (These events were reported in the January 1984 QST, pg 34.)

At about this time, the experiments began experiencing severe interruptions due to: 1) my finishing up grad school at Cornell, 2) selling a house, 3) buying another house, and of course, 4) moving the family and changing jov assignments. We did not get re-established at rhe new QTH until October '83.

Since that time a Baudot and ASCII conventional RTTY capability has been overlayed onto the system -- a seemingly trivial task which took several months and was anything BUT trivial, and we have gained quite a bit more experience using the system on the air.

FINDINGS

I was very surprised to find that, contrary to most of what I have read in various places, 300 bps is a very viable data rate at HF (we have been using 20 meters). We haave very rarely found selective fading or any other natural phenomenon to be aa cause for reducing data rate. We have generally found thaat if we have enough signal strength to run at 150 bps, we can run as well at 300 bps.

The most significant impediment to communications in our experience has been QRM (ofter intentional), aand usually by aa station 20 dB or so stronger than our desired distant end station. The ARQ system responds to these interludes by patiently waiting until reasonably good data blocks begin appearing again, and this usually allows us to "outlast" whoever it is trying to disrupt us. (We have used a technique of frequently ID'ing in CW when we think some unenlightened sole is jamming us because he might think we are a non-amateur link; this seems to help about half the time.)

Our initial hypothesis that 425 Hz would be the ideal frequency shift to support the maximum legal data rate of 300 bps on the HF bands has been borne out. This shift works quite reliable at 300 bps with the homebrew TU's we are using, and allows a 300 bps signal to fit nicely into a 1200 Hz receiver bandpass.

CODE WEAKNESSES

In one of my earliest articles about the Reed-Solomon code I had chosen, I discussed the code's theoretical probabilities for failure: NOT detecting and flagging corrupted blocks that exceeded the code's ability for full correction. After using the system for many many hours we came to the conclusion that the approximate 10% probability of an undetected baad block when running the decoders at the full 3-error-correcting level was not acceptable. The biffest problem arose when an Acknowledge Frame was improperly decoded!

The Acknowledge Frames are the receiving system's means of informing the transmitting system o which blocks of those sent during the last transmission were received correctly (or were fully correctable). Receiving aa corrupted Acknowledge Frame, on with incorrect block addresses in it, would sometimes completely disrupt the system when blocks not really ACK'd by the distant end would APPEAR to have been acknowledged. These blocks would not be retransmitted anymore, of course, so the receive system would become "hung up" waiting for blocks that were not forthcoming.

Once this was recognized for what it was, the short ter fix was to operate the decoders in a 2-error-correcting mode while ACK Frames were being received so that that probability of accepting an uncorrectable block would be reduced to about 1 in 10,000. This worked well, but the long term solution is to switch to a more powerful code.

NEW CODES

The ideal forward error correcting code for amateur HF aapplications would be able to correct a 40% or worse channel error rate, have a one in a million probability of failing to detect an uncorrectable block, and have a 50% or greater code rate (percentaage of useful information symbols in the block). For the FCC, we must also add that the symbols in the radio channel must look like standard ASCII; with an allowance for some extra "garbage" characters now and then (the check symbols).

My initial choice was an interleaved Reed-Solomon code with 4-bit symbols, and 15 characters to the block. I haave now decided, however, thaat something more powerful but probably less "efficient" would be a better compromise. (By less "efficient" I mean more check cymbols for a given number of information symbols.) The next code I am going to try will probably use a block length of about 32 symbols, with about 70% of these being check symbols. I will be shooting for a correction rate of 30 to 40%, a 1 in 1,000,000 probability of an undetected bad block, aand ASCII looking symbols in the channel. I will accept whatever efficiency I end up with to meet the above requirements.

SATELLITES

We also want to set up a system that is optimized for the AMSAT Oscar 10 satellite link, with its particular problems. It turns out that this link is quite a bit different from a typical HF channel in a number of ways, and unfortunately in most ways it is much harder to work with. (Hopefully, the links through the elliptical orbit birds will be of fairly respectable quality once we can get one up there without having the booster ramming it as it is released.)

Old Dominion 100

Bill Pala
WB4NFB

The crew has survived another Old Dominion 100 mile ride and run. Through marsh and mountain and searing heat the noble band did persevere. This year we started planning six months ahead of time, but it still wasn't enough. Many good lessons were learned this time as we tackled an expanded communications job. The tracking of runners and horses was added over last years effort which consisted of emergency, administrative, and co-ordination traffic. Elton repeaters used on top of the mountain to tie the course together. In addition to an all new two meter repeater with UHF link, he assembled a Packet simplex repeater for the computer information network.

The Packet radio network developed by Bob Bruninga WB4APR and operated by Elton Sanders WB5MMB, Nancy Sanders KB4DAJ, Dave Borden K8MMO, Terry Fox WB4JFI, and Howard Cunningham WD5DBC consisted of three Commodore computers, TNCs and 202 modems. Quite a bit of effort went into writing and testing the software for this system and it did work for several hours before equipment failures and power interruptions finally killed the network. A vote of appreciation goes to these people for a fine effort--better luck is hoped for next year!

We wish to thank the following people who gave up their weekend and sleep/sanity to make

CALL	NAME	STATION
K8MMO	Dave Borden	4H Center
N4CHP	Bob Dasenbrock	Sherman's Gap
WB4JFI	Terry Fox	NCS
WD5DBC	Howard Cunningham	NCS
WB3KDU	Hal Feinstein	Ride manager
WB4JFC	Dave Jones	Trail Master
W3EW	Ed Westbrook	Run Manager
W8DIC	Ted Compton	Veach Gap
K3CDV	Gary Koerner	Hickory Lane
WB5MMB	Elton Sanders	Twin Lakes
KB4DAJ	Nancy Sanders	Twin Lakes
WA3TOY	Kurt Fritsch	McCoy's Ford
W4KXE	Howard Miller	684 at trail
KE4KF	Frank Tayler	Picket Springs
K2YUB	Jay Hochstaine	Bentonville
K4ADE	Bob Ageton	Run Manager
NT4S	Robert Kinsley	Land's Run
WD4HLG	Ernie Brown	Camp Roosevelt
KA4LHJ	Robert Watkins	Camp Roosevelt
WB4DAK	Phil Rinaca	Yates
K4FON	Jim Triplett	Edinburgh Gap
N8FJB	Jim Newton	NCS
NC4B	Walt Quitter	NCS
KD4TZ	Clifford Kitz	Woodstock Gap
KF4HP	William Armstrong	Seaman's Farm
WB4NFB	Bill Pala	Browntown
	Michael Short	684 at Trail
	Col. Pala	613-Split

A well done to all. AMRAD will probably use the Fall 50/50 ride to test the network again. We plan at this time to use five Packet stations next year to better cover the course. We also will be working on hardening the equipment to withstand the environment. This last is a good place for you budding Mil-Spec Engineers to volunteer.

AMRAD Amateur Radio Research and Development Corporation

Membership Application/Renewal

Mail to: **William P. Pala, WB4NFB**
5829 Parakeet Drive
Burke, VA 22015

See reverse for overseas mailing rates.

	Annual
Dues: Regular	$15
2nd in family same adr	8
Full-time student	5

Please make checks payable to AMRAD.

Name_____
Ham Call_____ Home Phone( )_____

Address_____
City,
State/Prov_____ ZIP/PC_____

I agree to support the purposes of the Corporation.

Class License_____ ☐ARRL Member
Interests:
☐Packet Radio ☐Spread Spectrum
☐RTTY ☐Deaf TTY
Computer model_____
Microprocessor type_____

*Signature*_____

The Amateur Radio Research and Development Corporation (AMRAD) is a worldwide club of over 500 amateur radio and computer experimenters. It is incorporated in Virginia and is recognized by the U.S. Internal Revenue Service as a tax-exempt scientific and educational organization.

The purposes of AMRAD are to: develop skills and knowledge in radio and electronic technology; advocate design of experimental equipment and techniques; promote basic and applied research; organize technical forums and symposiums; collect and disseminate technical information; and, provide experimental repeaters.

Meetings are on the 1st Monday of each month at 7:30 P.M. at the Patrick Henry Branch Library, 101 Maple Ave E, Vienna, VA. If the first month is a holiday, an alternate date will be announced in the newsletter. Except for the annual meeting in December, meetings are normally reserved for technical talks - not business.

WD4IWG/R is an open repeater for fm voice and digital communications, especially for experimental modes. It is located at Tyson's Corner, McLean, VA. It features semi-private autopatch available to licensed members. Frequencies are: 147.81 MHz in, 147.21 MHz out. The repeater director is Jeff Brennan, WB4WLW.

WB4JFI5/R is a 1200-baud half-duplex packet repeater located on the south leg at the 200 ft. level of the WDVM/WJLA TV tower. The tower is located at Wisconsin Ave. and River Rd. in northwest Washington DC, and the repeater runs the AX.25 level 2 protocol. The frequency for the WB4JFI5 packet repeater is 145.01 MHz simplex.

The AMRAD CBBS, 703-734-1387, is operated by Terry Fox, WB4JFI. The system accepts 110, 300, 450 and 600-baud ASCII, Bell 103.

Handicapped Education Exchange, 301-593-7033, is operated by Dick Barth, W3HWN. HEX accepts 110/300-baud ASCII and Baudot deaf TTY/TDD calls.

AMRAD is affiliated with the American Radio Relay League (ARRL), Foundation for Amateur Radio (FAR), Northern Virginia Radio Council (NOVARC) and the Mid Atlantic Repeater Council (T-MARC).

The AMRAD Newsletter is mailed monthly to members and other clubs on an exchange basis. Technical articles, product announcements, news items, and other copy relating to amateur radio and computing are welcome. Honorariums at a rate of $0.10 per 50-character printed line ($20 maximum per author per issue) are paid for original material accepted. Classified ads are free to members. Commercial ad inquiries are invited. The editor reserves the right to reject or edit any portions of the copy. Items should be mailed by the 8th of the preceeding month to Editor, AMRAD Newsletter, P.O. Drawer 6148, McLean, VA 22106. Full permission for reprinting or quoting items is granted provided that credit is given to both the author and the newsletter. Mailing to U.S. and possessions is by 3rd Class bulk mail. Canadian and Mexican addresses add US$2 for postage. Overseas readers add US$8 for air mail or US$2.30 for surface.

AMRAD officers for 1983 are:

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Richard Barth, W3HWN	301-681-7372	Alternate HEX Sysop
David W. Borden, K8MMO	703-450-5284	Director
Jeffrey Brennan, WB4WLW	703-354-8541	Director Repeater Trustee
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Terry L. Fox, WB4JFI	703-356-8334	Director President Editor CBBS Sysop
William P. Pala, Jr.,	703-323-8345	Director Secretary
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Elton A. Sanders, WB5MMB	703-281-1298	Director
Howard Cunningham, WD5DBC	703-425-6852	Correspond. Secretary

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